MARKETING RESEARCH REPORT NO. 658

OPERATING COSTS IN PACKING MIXED FEEDS

With Emphasis on Labor and Capital

MARKETING ECONOMICS DIVISION ECONOMIC RESEARCH SERVICE U.S. DEPARTMENT OF AGRICULTURE

PREFACE

This is the third in a series of studies conducted by the U.S. Department of Agriculture on the different phases of feed manufacturing. Earlier studies were reported in "Labor and Capital for Pelleting Formula Feeds," Marketing Research Report No. 463, and "Labor and Capital for Mixing Formula Feeds," Marketing Research Report No. 564.

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SUMMARY

On the basis of data from records of feed manufacturers in 35 States, two packing center models were developed representing small and large plants manufacturing mixed feeds for delivery in both bulk and packaged form. The models provide information on standards against which to measure costs, labor, equipment, and operating practices in the packaging process. The models are typical of packing centers in feed plants producing 80 and 200 tons of mixed feed per 8-hour shift, which package 80 percent of their production.

Equipment for the smaller model packing center producing 65 tons of bagged feeds per 8-hour shift costs about $12,900. Labor requirements are 7.95 man-hours per shift. Annual operating costs, assuming the plant operates 260 days, are $6,650, or about 39.3 cents a ton of packaged feed. If this plant is operated two 8-hour shifts a day, packing costs decrease to approximately 36.6 cents a ton.

In the larger model packing 160 tons of packaged feed per 8-hour day, the equipment cost is $29,220. Labor required to package this amount of finished feed in one 8-hour shift is 14.35 man-hours. Total annual operating costs for this model are $12,391, assuming 260 days of operation. Packing costs are about 29.8 cents a ton if the center is operated one shift a day and 27.1 cents a ton if the center operates two shifts a day.

The smaller model packing center can produce about the same amount of packaged feed in 20 hours of operation as the larger model can produce in 8 hours. With both models packing about 42,000 tons of finished feed a year, the larger packing center would have a cost advantage of about 20 percent.

A number of factors affect the cost of packing feeds. Some of these factors have plantwide influence.

Utilization of equipment greatly influences total cost per ton. In both packing center models, the cost per ton in a 1-shift operation is increased about one-third if the percentage of feed packed is reduced from 80 percent to 30 percent of plant output. Likewise, if both models operate two shifts, the cost per ton is increased about 20 percent with the smaller percentage packed.

Decisions involving capital investment in new or additional equipment are among the most important which a feed manufacturer must make. Management must be supplied with all cost information possible for the justification of any capital expenditure. A decision is based on the increased benefits from reduced feed manufacturing costs and improved quality of the finished feed made possible by the capital investment.

Survey feed mills tended to have more packing equipment than the model of comparable size. Utilization of packing equipment varied greatly among the survey plants. Those with the highest percent utilization tended to have the most efficient operations.

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INTRODUCTION

Annual production of prepared animal feed was estimated to be about 50.4 million tons in 1961, according to a recent survey conducted by the Bureau of the Census. 1/ This total includes 43.5 million tons of complete feeds and 6.9 million tons of feed supplements and concentrates. It is not possible to make exact comparisons with earlier years; however, there is evidence that production of prepared animal feed has risen steadily over a long period. In 1958, the year of the last Census of Manufacturers, establishments primarily engaged in the manufacture of prepared animal feeds reported production of about 29.3 million tons of complete feeds, supplements, and concentrates. Production had increased about 36 percent since 1947.

In 1963, an industry survey indicated that about 52 percent of the commercial formula feed manufactured was packaged. Average quantities of feed packaged varied from a high of 73 percent in the East North Central Region to a low of 30 percent in the Pacific Region. 2/ Individual plants vary, some packaging no feed and others packaging up to 100 percent of the feed produced. The quantity of mixed feed packaged is dependent on the type of agriculture in the area, size of livestock or poultry producing units, and customer preference. There is a rapid trend toward the use of bulk feeds, especially by the mills located in the consuming areas.

The delivery of mixed feeds in bulk form has increased during recent years in varying degrees throughout the country. However, bagged feeds still predominate in many areas. Originally, bulk feed was used mainly by large feeders who could justify the investment in large storage bins. Today, the mixed feed industry uses multicompartment delivery trucks of many sizes, permitting almost any feeder to obtain bulk feeds. For many feeders, however, use of bulk feed is less economical than use of packaged feed.

Bulk handling of mixed feeds is not always the most profitable method of merchandising for the feed manufacturer. The cost of manufacturing a ton of mixed feeds is the same regardless of whether the finished product is packed or sent to the feeder in bulk form. However, the equipment and facilities for handling and delivering bulk feeds require a large investment. The feed manufacturer must determine whether the demand for bulk feeds in his sales area justifies the investment. He also needs to analyze the potential of his plant by considering the number and types of feeds handled, the tonnage of each produced, and the size of the average order. Most feed manufacturers find that they are forced by competition to have both bulk and packaged feeds available for feeders.

1/ U.S. Bureau of Census. Census of Manufacturers. Current Indus. Rpts., Ser. M20-E (61)-1, May 13, 1963.

2/ The survey was made by the Tonnage Reporting Service of the American Feed Manufacturers Association, Inc., Feb. 1964.

With a decline in the volume of packaged feed, the growing variety of feeds, and the increasing variety in size of packages, costs of packaging continue to rise. Despite the changing picture, many feed manufacturers are still operating the basic packaging systems used 10 years ago. This study should be helpful to management in improving operating efficiency through the use of modern equipment, better production scheduling, and better utilization of manpower and machines in the packaging department.

SOURCE OF DATA

Most of the information on which this report is based was obtained in a mail survey made in November 1961. Questionnaires were sent to feed manufacturers in 34 States. The manufacturers had attended one or more of the annual schools sponsored by the Midwest Feed Manufacturers Association. They were well acquainted with the research being done and with the definitions of terms used in discussing the packing cost center.

The questionnaire was concerned with the overall production of mixed feed in the feed plant. Information was requested on the number of man-hours required to handle a given volume through each of the cost centers in the feed plant during the month of November 1961. A major portion of the survey questionnaire was designed to obtain data for the packing cost center on (a) the most popular sizes of packaging centers, (b) the various types and kinds of equipment used in the packing operation, and (c) the relative importance of the various kinds of feeds packaged and how this affected the mill's production schedule.

Other pertinent information needed to complete this analysis, such as equipment replacement costs, electricity rates, wage rates, and labor standards, was obtained from industry and U.S. Government sources.

THE PACKING OPERATION

The packing cost center begins with the finished feed--pellets, crumbles, or mash--in the holding bins over the packing scales, or the feed in the holding bins over the molasses blender for making dairy or molasses feeds. The work involves weighing, packing, and sewing bags for all the finished feed bagged. The work of obtaining empty bags and identification tags from storage is all included in this center. The cost center ends at the point where the bags of finished feed are removed from the sewing machine.

The weighing and packing of finished feed is similar in both large and small mills. Equipment selected to do the job depends on many factors, including tonnage requirements, types of materials packaged, space available for installation of equipment, storage space for finished products, and capital available for equipment.

Equipment

Packing scales of two general types are used in mixed feed plants--the gross packing scale and the automatic net packing scale. The gross packing scale is the type on which the empty bag actually serves as the weigh hopper. It is suspended from the filling spout connected to the scale beam. The scale operator must manually open a slide or gate to initiate the weighing. As the correct weight is accumulated

in the bag, he closes the slide or gate. Most gross packers have an accuracy indicator to show whether the weighing is light or heavy. If the weighing is light, the operator adds material to bring it up to the desired weight. If the weighing is heavy, the operator manually removes the excess amount.

A semiautomatic gross packer is slightly more automated than the simple gross packing machine. The packing scale has a catch gate that is designed to close automatically just prior to the accumulation of the desired weight. This feature allows an operator to close a bag that has been filled while the scale is making another weighing.

Gross packing scales can be used to pack most free-flowing feeds into bags ranging in capacity from 25 to 150 pounds. Packing rates vary depending on the operator's skill and the material bagged. On the average, one man can pack and sew four to six 100-pound bags a minute.

Gross packing scales can also be used to bag materials which do not flow readily. With these materials, a belt feeder is used between the storage bin and the scale to regulate flow. The belt feeder automatically starts and stops as the catch gate opens or closes. This mechanical feeder makes possible easier and more accurate weighing than with gravity-fed scales, because it maintains an even flow of feed.

Gross packing scales have several advantages: (1) low initial cost, (2) easy installation, and (3) low maintenance cost. However, they are relatively slow and their accuracy depends to a large extent on the skill of the scale operator.

An automatic net bagging scale is usually used for weighing 50- and 100-pound bags of free-flowing feed products, such as grain, scratch feed, pellets, and crumbles. The mechanically operated scale is capable of weighing six to eight 100-pound bags or eight to ten 50-pound bags per minute. This scale with a slight modification can also handle 25-pound bags.

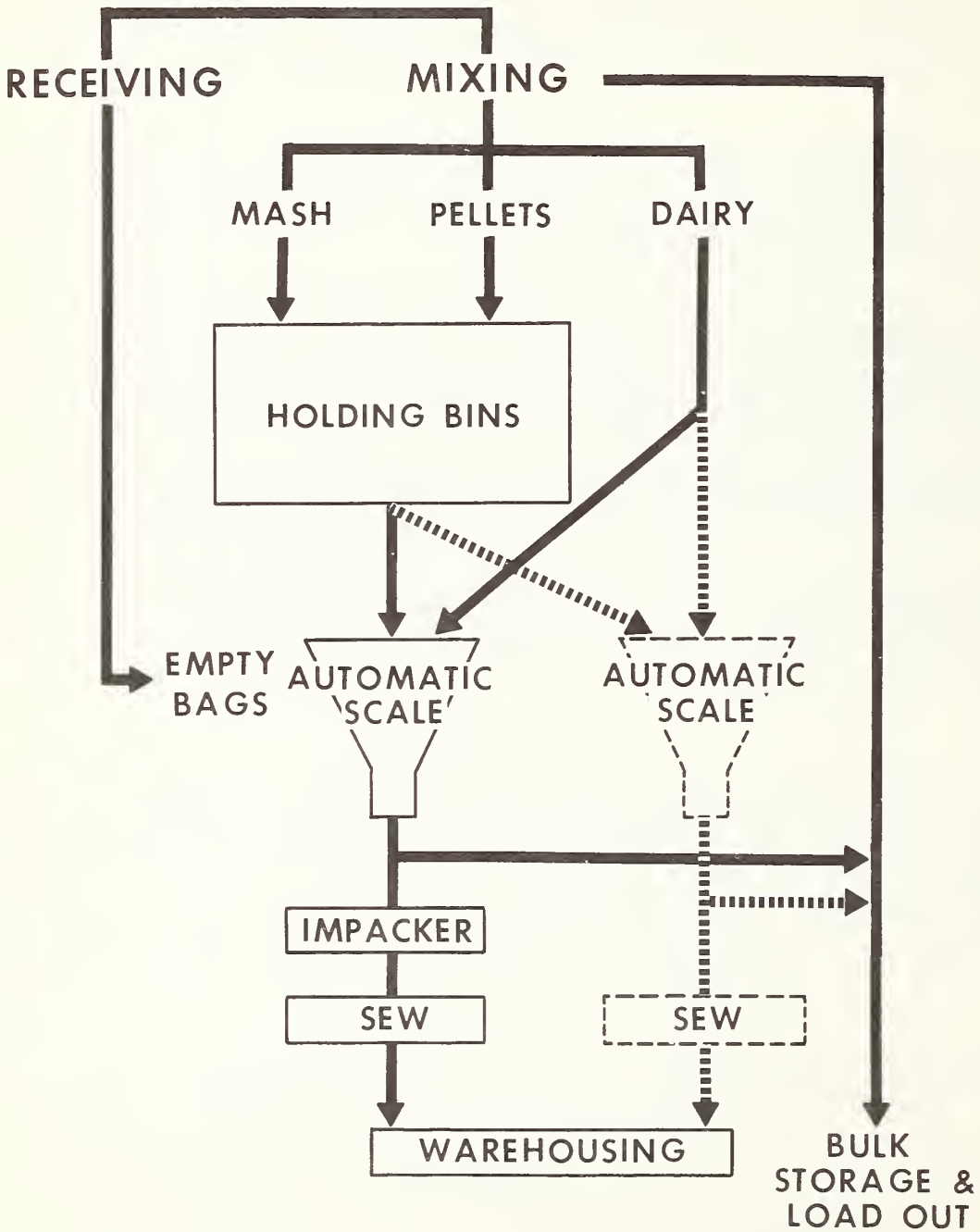
The automatic net bagging scale may be mechanically operated, or it may be power operated. The power-operated scale is used with a variety of control-type feeders, such as screw feeders, vibrating feeders, belt feeders, or motor-driven agitators. It uses air-operated catch gates, air-operated or electrically operated discharge gates, and other power accessories. It has a wide range of weighing rates, depending on the accessory equipment, and can handle a large variety of products. It will pack from ten to fourteen 100-pound bags or from fifteen to twenty-two 50-pound bags a minute. Scales of this type offer greater production, cleaner operations, and greater versatility than the other scales discussed. However, they cost more, and are designed primarily for medium-sized and large mills.

Automatic net packing scales, whether mechanically operated or power operated, offer an additional advantage to manufacturers who must handle bulk feeds. A scale of this type may be used for bulk load-out by placing a movable spout below the scale in place of the bag, so that the finished feeds can be directed into a bulk truck. There are numerous other accessories that may be added to this scale for the purpose of bulk loading. Requirements of the individual plant will determine the type of scale best suited and the accessories needed.

Flow Diagram

The diagram in figure 1 outlines the packing operation and delineates the packing cost center as used in the study. The flow illustrated is typical of the two models

FLOW DIAGRAM FOR PACKING CENTER



SOLID LINES INDICATE OPERATIONS OF PACKING CENTER PACKAGING 65 TONS OF FEED IN 8 HOURS. DOTTED LINES SHOW ADDITIONAL OPERATIONS FOR CENTER PACKAGING 165 TONS IN 8 HOURS.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 2727-64 (3) ECONOMIC RESEARCH SERVICE

Figure 1

described in this report, both of which use the power-operated automatic net packing scale. Gravity flow is used in most feed plants wherever it is possible and practical. Some feeds such as mash, pellets, and crumbles are usually free flowing and will flow directly from the storage bins into the scale. For feeds that do not flow evenly, such as dairy feeds or bulky feeds high in molasses, the flow must be regulated by a belt feeder.

Finished feeds flow from the storage bins or, in the case of molasses feeds, directly from the molasses blender. Automatic scales are preset to weigh the desired amount per bag. Empty bags are obtained from storage before bagging. Tags are also obtained for each type of feed before the packing begins. Care must be taken to see that the proper bags are being used and that identification tags agree with the product being packed.

When the preparation for bagging is completed, the packing operator opens the proper storage bin slide to allow the mixed feed to flow into the scale. An empty bag is placed on the scale spout and the weigh hopper is dumped. When a change in formulas occurs, the packer must set aside several bags of the new feed so that no improperly mixed or contaminated feed will go out.

After the feed is packaged, it is moved a short distance on a belt to the sewing machine, where a tag is inserted and the bag is sewed shut. From the sewing machine, the feed goes into the warehousing cost center. Warehousing may consist of direct loading into rail cars, trucks, or warehouse storage for future sales.

During the packing of each run of feed, the packer must check the weights of the packaged feed to insure a weight equal to or slightly more than the quantity stated on the bag or tag. It is possible for the weights measured in the hopper scale to be off, particularly if the material is not free flowing.

Labor Responsibility

Labor standards are estimates of production man-hours necessary to perform an operation or operations within a given plant, using specified equipment. The standards used in this report include generally accepted allowances for personal time, delays, and maintenance.

In many feed plants, the packer spends his full time in packing mixed feeds. In some plants, however, facilities are arranged so that certain production workers perform several jobs at the same time. For example, the pellet mill operator may pellet, crumble, and pack the finished product. This arrangement tends to make more efficient use of the operator's time. However, it may not be the best allocation of personnel when the entire feed plant is considered.

A packing operator generally performs the following duties in an 8-hour shift:

(1) Follows production schedule established by the supervisor.

(2) Before each new feed is bagged, obtains proper bags and tags.

(3) Opens slide of storage bin to allow the proper feed to flow into the scale.

(4) Sets off the first few bags of each new feed for checkweighing and inspecting the contents for contamination.

(5) Sews bag, with proper tag inserted at top of the bag.

(6) Samples and checkweighs finished product periodically.

(7) Greases, oils, and makes minor adjustments to scale and sewing machine.

(8) Periodically cleans equipment and packing area.

(9) Maintains reports on quantities and kinds of feed packed, equipment problems, and other matters pertaining to the normal routine.

These duties vary from plant to plant depending on management, facility arrangement, specialization of workers, and other related factors.

A packing operator's responsibilities are by no means small. One of his major responsibilities is quality control. Packaging is the last sequence in the manufacturing process where the feed can still be visually inspected. An experienced worker can often detect undesirable characteristics in mixed feeds, such as off color, improper pellet size, too many fines in crumbles, and so on.

An important duty of the packing operator is to checkweigh the packaged feed and to adjust the scale for the proper weight. This is to insure against shortweights and overweights. Ajustments are necessary because the density per cubic foot of mixed feed changes with (1) the formula of feed manufactured and (2) the frequent variation occurring in the densities of the feed ingredients used.

A manufacturer must by law guarantee a minimum quantity of mixed feed in the bag. Therefore, automatic scales with a tolerance of plus or minus 4 ounces must be set to give a minimum of, for example, 50 pounds and 4 ounces for a 50-pound bag. If the manufacturer attempts to reduce this quantity of overage, he faces repackaging expense or an imposed fine if feed inspectors find short weights. On the other hand, if the overage is much above this the giveaway feed will amount to quite a few thousands of dollars a year.

Assumptions Used for Model Packing Centers

Using the survey data as a basis, two model packing centers were established, representing plants of different sizes. Estimates of packing costs in each center were based on the assumptions listed below.

Type of operation.--The plants package about 80 percent of the mixed feed production, and deliver the other 20 percent as bulk mixed feed. The feed packed is about one-third mash, one-third pellets and crumbles, and one-third low-molasses-content dairy feed. About half the mash and pelleted feed is packed in 50-pound paper bags and half in 100-pound textile bags. Dairy feed is packed only in 100-pound textile bags.

Wage rates.--Production labor is paid $1.86 per hour for the day shift and $1.96 for the night shift. Supervisors are paid $2.50 an hour for the day shift and $2.60 for the night shift. Wage rates for maintenance of equipment are $2.25 per hour for the day shift and $2.35 for the night shift. Overtime work is paid at time-and-a-half. 3/

3/ Bureau of Labor Statistics, U.S. Dept. Labor. Employment and Earnings. 1963.

Depreciation.--Annual depreciation is based on the straight-line method of computation, assuming a 17-year useful life for all items except the sewing head, which has a 10-year life, and assuming a zero scrap value at the end of the life period. These rates are consistent with guidelines of the Internal Revenue Service. 4/ Although a case may be made for somewhat higher depreciation charges for plants operating more than one shift a day, annual hours of operation were not considered in making the estimates for the models. Such depreciation is likely to be small in relation to time depreciation and obsolescence, particularly in a plant with an adequate maintenance program. Depreciation of building space occupied by the packing center is not included. Plants differ widely in location, design, and construction, and it would be difficult to make a representative estimate.

Interest.--Interest on investment is included in production costs, without regard to whether the funds are borrowed or are those of the owner. Interest is estimated at a rate of 6 percent on the average investment in equipment; that is, on one-half the original investment. Interest on building space required by this operation is not included.

Electricity.--An average charge of 3.25 cents per kilowatt-hour is assumed. Costs were calculated on a straight-line basis rather than on a growth curve as is normally done for utility rates. An earlier study indicated that the total cost of electricity increases in direct proportion to the increase in tonnage of feeds packaged. 5/

Model Packing Center for Small Plant

The small packing center model is typical of feed plants packaging around 65 tons of mixed feed per 8-hour shift--about the amount that can be handled by one worker. The feed plant is assumed to have a total production of 80 tons of mixed feeds per 8 hours, or about 21,000 tons annual production operating one 8-hour shift 260 days a year. If the plant operated two shifts a day, then the annual production would double.

Equipment

The total investment in new equipment for this model center is estimated at $12,900, including installation charges of 33 percent (table 1). The power-operated automatic net packing scale with automatic vibrator feeder costs about $6,340, about 50 percent of the total cost of equipment. An impacker is one of the major pieces of equipment. The impacker is used to settle down bulky material, such as dairy feed, so that the bag may be closed. Its cost is $3,067, one-fourth of the total equipment investment in the center. Many small mills in the industry do not have this piece of equipment. However, it is important if dairy or bulky feeds make up a large percentage of the total feed packed. The impacker saves packing time since the operator does not have to shake the bag manually to get the feed packed down. It also makes possible the use of smaller, less costly bags.

Other items of equipment are a bag conveyor with adjustable belt at $1,320, a sewing pedestal at $1,200, and a sewing head with actuator and clipper at $973. The

4/ Depreciation--Guidelines and Rules. U.S. Internal Revenue Service Rule No. 456 (7-62), 56 pp., 1962.

5/ Vosloh, Carl J., Jr., and Askew, W. E. Custom Feed Milling in the Midwest. U.S. Dept. Agr. Mktg. Res. Rpt. 273, Sept. 1958. Schedules of electric rates have been discussed with Rural Electrification Administration personnel, who state that no significant changes have been made in rates.

Table 1.--Approximate cost and depreciation of equipment for model center packing 65 tons of feed per 8-hour day

Equipment 1/	Approximate cost 2/	Depreciation	
		Average life	Annual Cost
	Dollars	Years	Dollars
Packing scale, duplex with automatic vibrator feeder	6,340	17	373
Bag conveyor, adjustable belt	1,320	17	78
Sewing pedestal	1,200	17	72
Sewing head, with actuator and clipper	973	10	97
Impacker	3,067	17	180
Total	12,900	--	800

1/ Each item of equipment listed is complete with all accessories and parts (except elevators and conveyors) necessary for complete installation.

2/ Includes estimated installation charge of 33 percent; some pieces of equipment may require a higher or a lower installation charge.

sewing head with actuator and clipper, like the impacker, is a timesaving feature. Tops of the bags are guided into the machine and the actuator starts the sewing operation automatically on contact. The thread clipper cuts the thread chain to the shortest possible length, which saves string cost and improves appearance of the packaged feed.

Operating Costs

Direct production labor for this model packing center is 7.95 man-hours per 8-hour shift (table 2). The center requires one worker about full time. In addition, the plant foreman or supervisor spends about 1 hour per shift in this center. If the plant operates two 8-hour shifts, both production and supervisory labor are doubled. Annual production labor cost for the model center is $3,845 for a 1-shift operation, plus $650 for supervisory labor. For a 2-shift operation, labor costs are more than twice as much--$7,897 for direct production labor and $1,326 for supervision--due to the higher wages paid the second shift workers.

The production schedule may vary between shifts if a plant operates more than one a day. In this model, however, the two shifts are assumed to average out to similar production schedules.

The annual depreciation on the equipment in the center is estimated to be $800 (table 1). The estimated interest charge is $387--6 percent of the average investment in equipment.

The packing operation uses less electricity than any other operation in the manufacturing operation. Electricity for the small model packing cost center is estimated at $90 a year for a single-shift operation and $180 for two shifts (table 3).

The annual labor cost of a fully adequate program for maintenance of equipment for the model is estimated to be about $878 for one shift a day and $1,794 for two shifts. These estimates are based on 1.5 man-hours maintenance per 8-hour shift.

Table 2.--Estimated labor requirements for model center [illegible] 8-hour shift and 160 ton[illegible] in two 8-hour shifts

Job	Labor standards (man-hours)	Quantity in one shift	Man-hours		Man-hours per ton
			[illegible]	[illegible]	
Production labor:					
Pack and sew:					
Mash:					
50-pound bags	.083 per ton	11 tons	.91	1.83	
100-pound bags	.067 per ton	11 tons	.74	1.47	
Pellets and crumbles:					
50-pound bags	.067 per ton	11 tons	.74	1.47	
100-pound bags	.048 per ton	11 tons	.53	1.06	
Dairy feed:					
100-pound bags	.067 per ton	21 tons	1.41	2.81	
Obtain empty bags and tags	.062 per change	12 times	.74	1.49	
Clean up	.075 per change	12 times	.90	1.80	
Formula changes	.055 per change	12 times	.66	1.32	
Allowance 1/	---	---	1.32	2.65	
Total production labor	---	---	7.95	15.90	0.12
Supervision	---	1 hour	1.00	2.00	0.02
Total labor			8.95	17.90	0.14

1/ 20 percent of time allowed for worker's personal requirements.

The packing scale and the sewing machine require the most attention. No estimate is included on costs of repair parts and maintenance supplies, since they vary greatly from plant to plant.

In table 4, total annual operating costs for this model packing cost center are summarized for operations with 1,2, and 3 shifts, and also with 1 1/2 and 2 1/2 shifts. Total annual operating costs for this model range from $6,650 if the model operates one shift to $18,117 if it is operated three shifts.

Model Packing Center for Large Plant

The model packing center representing the larger plants is assumed to have a packing capacity of 160 tons of mixed feeds per 8-hour day, and to be part of a feed mill with a total output of 200 tons in 8 hours. The annual packing capacity is 41,600 tons if operating one 8-hour shift 260 days a year, or 83,200 tons if operating two 8-hour shifts.

Equipment

The total investment in new equipment for the large model center is estimated at $29,220, including an installation charge of 33 percent (table 5). Two automatic packing

Table 3.--Annual electric power requirements and costs for model center packing 65 tons of feed in one 8-hour shift and 130 tons in two 8-hour shifts

Equipment and manufacturers' rating of motor	Motors	Total adjusted horsepower 1/	Motor operation per shift		Electric power per year		
			Times turned on	Time required	Use 2/	Cost 3/	
						1 shift	2 shifts 4/
	Number	Horsepower	Number	Hours	Kw.-hr.	Dollars	Dollars
Vibrator feeder with power-grip bag holder	1	5/	--	4.33	1300	42	84
Bag conveyor, 3/4-horsepower motor	1	.88	12	4.33	738	24	48
Sewing machine, 1/2-horsepower motor	1	.59	--	4.33	485	16	32
Impacker, 3/4 horsepower motor	1	.88	4	1.41	240	8	16
Total	--	--	--	--	2763	90	180

1/ Electric motors under 100 horsepower must be adjusted for average efficiency by use of 0.85 coversion factor.
2/ Kilowatt-hours = Number of hours operating per day times adjusted horsepower times kilowatt-hour conversion factor (0.746) times number of operating days (260).
3/ At 3.25 cents per kilowatt hour.
4/ Single-shift cost is doubled for 2-shift operation.
5/ 110 volts a.c. 60 cycles, single phase, 10.51 amperes.

Table 4.--Total annual operating cost, model center packing 65 tons of feed per 8-hour shift 1/

Cost item	1 shift (16,900 tons per year)		1½ shifts (25,300 tons per year) 2/		2 shifts (33,800 tons per year)		2½ shifts (42,300 tons per year) 2/		3 shifts (50,700 tons per year)	
	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
Labor:										
Production	3,845	58	6,729	63	7,897	64	10,781	66	11,949	66
Supervision	650	10	1,139	11	1,326	11	1,823	11	2,002	11
Depreciation on equipment	800	12	800	7	800	6	800	5	800	4
Interest on investment	387	6	387	4	387	4	387	2	387	2
Electricity	90	1	135	1	180	1	225	1	270	2
Maintenance 3/	878	13	1,537	14	1,794	14	2,460	15	2,709	15
Total	6,650	100	10,727	100	12,384	100	16,476	100	18,117	100

1/ Costs are calculated using 8 hours per shift and 260 days per year.
2/ Workers receive time-and-one-half pay for the 4 hours overtime.
3/ Labor cost alone; excludes cost of replacement parts and maintenance supplies. Maintenance employees' time estimated in relation to equipment cost. (1.5 man-hours per shift based on in-plant standards established at the Feed Production School of 1956.)

Table 5.--Approximate cost and depreciation of equipment for model center packing 160 tons of feed per 8-hour day

Equipment 1/	Quantity	Approximate cost 2/	Depreciation	
			Average life	Annual cost
	Number	Dollars	Years	Dollars
Automatic packing scale with automatic belt feeder	2	19,170	17	1,129
Bag conveyor, adjustable belt	2	2,639	17	155
Sewing pedestal	2	2,399	17	141
Sewing head, with actuator and clipper	2	1,945	10	195
Impacker	1	3,067	17	180
Total		29,220		1,800

1/ Each item of equipment listed is complete with all accessories and parts (except elevators and conveyors) necessary for complete installation.

2/ Includes estimated installation charge of 33 percent; some pieces of equipment may require a higher or lower installation charge.

scales costing about $19,170 account for 65 percent of the total investment, and an impacker costing about $3,067 accounts for 10 percent. Some plants of this size pack dairy and other bulky feed mixes without the impacker, but this usually results in more time spent in packing and a higher bag cost because of the need for larger bags. Cost of other major pieces of equipment in the model are $2,639 for the bag conveyors with adjustable belts, $2,399 for the sewing pedestals, and $1,945 for the sewing heads with actuator and automatic clipper.

Operating Costs

Production labor is the largest single item in the total packing cost. It is assumed that this model center requires two packer operators working a total of 14.35 production man-hours to pack the output of 160 tons per 8-hour shift (table 6). The mill foreman or supervisor devotes about 2 hours per shift to this cost center. Annual production labor cost for a single 8-hour shift is $6,940 plus $1,300 for supervisory labor (table 8). This is about 67 percent of the total production cost. Because of the higher wages paid on the second shift, operating costs for two shifts are more than double these amounts --$14,253 for production labor and $2,652 for supervisory labor.

The estimated annual depreciation for equipment in this model is $1,800 (tables 5 and 8). For this center the interest, based on an investment of $29,220, is $877 (table 8). Interest on building space is not included. Total annual cost of electricity for this model is $304 for a single 8-hour shift operation or $608 for a 2-shift operation (tables 7 and 8). Seven electric motors, with a total of less than 5 horsepower, are used in this center.

Total annual labor cost for maintenance of equipment in this center is $1,170 for one 8-hour shift and $2,392 for two shifts (table 8). This estimate is based on 2 man-hours per 8-hour shift. The estimates of maintenance time are realistic, particularly

Table 6.--Estimated labor requirements for model center packing 160 tons of feed in one 8-hour shift and 320 tons in two 8-hour shifts

Job	Labor standards (man-hours)	Quantity in one shift	Man-hours		Man-hours per ton
			1 shift	2 shifts	
Production labor:					
Pack and sew:					
Mash:					
50-pound bags	.067 per ton	27 tons	1.81	3.62	
100-pound bags	.048 per ton	27 tons	1.30	2.59	
Pellets and crumbles:					
50-pound bags	.067 per ton	27 tons	1.81	3.62	
100-pound bags	.044 per ton	27 tons	1.19	2.38	
Dairy feed:					
100-pound bags	.067 per ton	52 tons	3.48	6.97	
Obtain empty bags and tags	.133 per change	12 times	1.60	3.19	
Clean up	.100 per change	12 times	1.20	2.40	
Formula changes	.055 per change	12 times	.66	1.32	
Allowance 1/			1.30	2.61	
Total production labor	--	--	14.35	28.70	0.09
Supervision	--	2 hours	2.00	4.00	0.01
Total labor			16.35	32.70	0.10

1/ 10 percent of time allowed for worker's personal requirements.

so for a mixed feed plant with a preventive maintenance program. Many mill managers have found it possible to eliminate serious and costly shutdowns and extend the useful life of many pieces of equipment with such a program. Management has found it advantageous to repair equipment while it is idle, so that production schedules are not affected. Cost of repairs and maintenance supplies are not estimated since they vary greatly from plant to plant.

Total annual operating costs for this model packing center are summarized in table 8. These costs range from $12,391 if the model is operated one shift to $32,773 if there are three shifts.

THE EFFECT OF VARIOUS FACTORS ON PACKING COSTS

The movement toward bulk feed delivery has created many problems for management. In areas with a concentration of large livestock farms, the greater proportion of the mixed feed is now sold in bulk. Many large plants have found it economically feasible to convert entirely to bulk delivery. Many smaller mills have had to make bulk feed available to keep customers. Packaged feeds, however, still account for about 52 percent of the industry's total sales of mixed feeds. Management therefore has a vital interest in appraising the most efficient methods of operation in plants that deliver some feed in bags and some in bulk form.

Table 7.--Annual electric power requirements and costs for model center packing 160 tons of feed in one 8-hour shift and 320 tons in two 8-hour shifts

Equipment and manufacturers' rating of motor	Motors	Total adjusted horsepower 1/	Motor operation per shift		Electric power per year		
			Times turned on	Time required	Use 2/	Cost 3/	
						1 shift	2 shifts 4/
	Number	Horsepower	Number	Hours	Kw.-hr.	Dollars	Dollars
Automatic packing scale, 3/4-horsepower motor	2	1.76	12	9.59	3,274	107	214
Bag conveyor, 3/4-horsepower motor	2	1.76	12	9.59	3,274	107	214
Sewing machine, 1/2-horsepower motor	2	1.18	--	9.59	2,196	71	142
Impacker, 3/4-horsepower motor	1	.88	4	3.48	595	19	38
Total	--	--	--	--	9,339	304	608

1/ Electric motors under 100 horsepower must be adjusted for average efficiency by use of 0.85 conversion factor.
2/ Kilowatt-hours = Number of hours operating per day times adjusted horsepower times kilowatt-hour conversion factor (0.746) times number of operating days (260).
3/ At 3.25 cents per kilowatt-hour.
4/ Single-shift cost is doubled for 2-shift operation.

Table 8.--Total annual operating cost, model center packing 160 tons of feed per 8-hour shift 1/

Cost item	1 shift (41,600 tons per year)		1½ shifts (62,400 tons per year) 2/		2 shifts (83,200 tons per year)		2½ shifts (104,000 tons per year) 2/		3 shifts (124,800 tons per year)	
	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total	Total cost	Percentage of total
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
Labor:										
Production	6,940	56	12,141	62	14,253	63	19,452	65	21,566	66
Supervision	1,300	10	2,275	12	2,652	12	3,648	12	4,004	12
Depreciation on equipment	1,800	15	1,800	9	1,800	8	1,800	6	1,800	5
Interest on investment	877	7	877	5	877	4	877	3	877	3
Electricity	304	3	456	2	608	3	760	3	912	3
Maintenance 3/	1,170	9	2,049	10	2,392	10	3,290	11	3,614	11
Total	12,391	100	19,598	100	22,580	100	29,827	100	32,773	100

1/ Costs are calculated using 8 hours per shift and 260 days per year.
2/ Workers receive time-and-one-half pay for the 4 hours overtime.
3/ Labor cost alone; excludes cost of replacement parts and maintenance supplies. Maintenance employees' time estimated in relation to equipment cost. (2 man-hours per shift based on in-plant standards established by the Feed Production School of 1956.)

Number of Shifts

Feed manufacturers surveyed gave varying opinions concerning the profitability and efficiency of operating a feed plant more than 8 hours a day. There are both advantages and disadvantages in operating more than one shift. Before World War II, large feed plants were built in centralized locations and maintained 16- to 24-hour-a-day production schedules to service large sales areas. However, in recent years the mixed feed industry has moved toward decentralization. Smaller and more efficient plants have been built in the consumption areas to be operated 8 to 16 hours a day.

The trend toward smaller, demand-oriented plants to meet competition has created a major problem for the large terminal feed mill operator who is servicing a large sales territory. If management decides to construct one or more smaller mills in the consumption areas, the terminal mill is placed at a distinct disadvantage. When the smaller mill starts operating, tonnage at the larger mill will go down and costs will rise. Competition and costs are so critical that the terminal mill may be forced to close.

Another problem develops when a mill sells a greater volume of mixed feed than it can manufacture in one 8-hour shift but not enough for two 8-hour shifts. Employees working more than the standard 8- or 10-hour shift receive time-and-a-half pay for the overtime hours. This sharply increases the costs per ton of the packing operation, where labor accounts for a large segment of cost. This increased cost has been overcome in some plants by operating a full crew for one shift and a partial crew on a second shift. The night crew is flexible in that its members perform work in several cost centers. However, it may not always be possible for the work in each of the different centers to be carried out at the same time.

In the models, packing costs per ton tend to decrease with an increase in shifts. This decrease is not as great as it would be with some other operation in which variable costs account for a smaller proportion of the total costs. Labor cost is the greatest variable and its influence is particularly noted in the cost per ton for 12 and 20 hours of operation (table 9). Overtime pay is responsible for the higher cost per ton for these levels of operation.

Table 9.--Total cost per ton for packing feed, by size of output and hours of operation, model packing centers

Operating time per day	Small model		Large model	
	Annual output	Cost per ton	Annual output	Cost per ton
	Tons	Cents	Tons	Cents
8 hours	16,900	39.3	41,600	29.8
12 hours	25,300	42.4	62,400	31.4
16 hours	33,800	36.6	83,200	27.1
20 hours	42,300	38.9	104,000	28.7
24 hours	50,700	35.7	124,800	26.2

The influence of variable costs may also be illustrated by a comparison of total packing cost in the two models. Total packing cost per ton for the smaller model is

about one-third higher than for the larger model if both are operating one 8-hour shift a day. When the smaller model operates 20 hours, producing about the same tonnage as the larger model operating 8 hours, the cost per ton is still about one-third higher.

Percentage Packed

The models are set up with the assumption that 80 percent of the total mixed feed produced in the plant is packed. However, mills in the industry of comparable size with the models pack from none to all of their total output. The changes in packing costs are not due solely to the percentage packaged, but also to the influence of certain other factors such as number of formulas packed, number of bag sizes used, and speed at which the feeds may be packed.

Cost per ton as influenced by the percentage packed is illustrated in table 10. This shows the relative change in costs in the two model packing centers resulting from changes in percentage of output packed, if the plants operate either one or two shifts. If the 80-ton mill packs only 30 percent instead of 80 percent of its production, the cost per ton will be increased by more than a third in a 1-shift operation. If the model is operating two shifts, the cost per ton is increased about 20 percent. The same basic cost relationship exists for the 200-ton plant, but with a lower level in cost per ton.

Table 10.--Cost per ton for packing with various percentages of output packaged and with one and two 8-hour shifts, model packing centers

Percentage of total feed packed	Packing centers					
	Small model			Large model		
	Per shift	1 shift	2 shifts	Per shift	1 shift	2 shifts
	Tons	Cents	Cents	Tons	Cents	Cents
80 percent	64	39.3	36.6	160	29.8	27.1
70 percent	56	40.6	37.6	140	30.8	27.6
60 percent	48	42.2	38.3	120	31.9	28.2
50 percent	40	44.2	39.3	100	33.4	29.1
40 percent	32	47.5	40.8	80	36.2	30.4
30 percent	24	53.0	43.6	60	40.8	32.4

When a feed mill, particularly a small one, reaches this low volume of feed packed, the production costs per ton increase rapidly. This is a major problem for many manufacturers. Bulk facilities are costly, and there is not always sufficient tonnage to justify their installation. However, many manufacturers have been forced into such a move by competition. The result for many plants is a high cost per ton for handling bulk feed and an increasing cost per ton for packing feeds. Some feed mills will never handle all their finished feeds in bulk; there could be others which will never handle any bulk feed. It is a major and continuing problem for the mill management to keep abreast of local feeding practices and preferences and be ready to meet them with a solution.

Package Sizes

As mentioned previously, the size of package makes a difference in the packing cost per ton. In the models, all the dairy feed is assumed to be packed in 100-pound bags, and half the mash, pellets, and crumbles in 50-pound and half in 100-pound bags. If it is assumed that the total output is packed in 50-pound bags, the labor cost per ton increases about 15 percent in both models. On the other hand, if all finished feeds are packed in 100-pound bags, the labor cost decreases about 10 percent.

Changing the size of bags will also affect other costs, both fixed and variable. Cost of bags, cost of warehouse storage space required for the finished product, and cost of handling will increase or decrease depending on the variety of bag sizes used.

INVESTMENT IN CAPITAL EXPENDITURES

Capital expenditures for the prepared animal feeds industry in 1962, according to the Survey of Manufacturers, were $55 million. This was about the same as in 1958 but less than in 1954. This amount represents expenditures for new plants, permanent additions and major alterations to existing plants, and new machinery and equipment.

Newly constructed mills are smaller than the large concrete plants built in past years. Feed manufacturers are building operating units to do the job for the least amount of money possible. The same philosophy prevails in renovating the older mills. Much consideration is given to the efficiency of the operation and what can be done to decrease the production cost. The big question that confronts management is: Should an existing piece of machinery be replaced with a more expensive piece of equipment to reduce manpower?

The two factors which must be considered in answering this question are: Is it economical, and will it improve the quality of the product? The manufacture of mixed feeds today is complex, and more care must be taken in the various processes incurred. It is not always a question of the cents per ton saved, but also how the end product will be affected.

The packing center is an area in most mills where renovation is needed. Many of the older mills are still using old and slow equipment. One of the most difficult decisions for management to make is when to scrap serviceable machinery for new and expensive equipment.

Management can, through an analysis of good records, obtain information on such important questions as savings in labor, equipment efficiency, and indirect costs that will result from adoption of a more up-to-date system. In many mills, packing center labor as well as other production labor involved in the manufacture of mixed feeds can be reduced with equipment providing a greater capacity flow.

Successful decisions regarding capital investment in new plants and equipment are based on more than a detailed analysis of cost records. Management must also evaluate the return on capital invested. There are at least three methods by which management can calculate such returns.

One of the most commonly used methods for evaluating capital investment is called "payback" or "payoff." It provides a rough estimate of the number of years required to recover the original investment. This method gives little information on timing of the earnings or amount of earnings after recovery of investment.

For example, assume that two employees can be replaced with a machine which costs $20,000 including all installation costs. The machine will have a useful life of 10 years with no salvage value at the end of that period, which means that annual depreciation amounts to $2,000. Total annual return from the new machine, calculated by substracting additional costs from gross savings on labor and other factors, is assumed to be $4,700. Using the "payback" method of evaluation, if would take about 4 1/4 years with this annual return of $4,700 to release the original investment of $20,000. This method of evaluation is likely to be used by firms whose cash resources for investment are limited.

For firms who have the cash resources for investment and wish to choose the most profitable way, the return-on-investment method is used in reaching decisions on investments in new equipment. This concept takes into consideration earnings realizable from investment, and expresses the result as a ratio of earnings to investment. The greatest disadvantage of this method is that it does not consider the time value of money; that is, it does not take into account the fact that if management spends money now rather than 5 years from now, then some consideration should be given to the interest cost for this period and possibly to immediate profits.

In the situation described, the ratio would be between the $2,700 net earnings and the $20,000 original investment, showing a yield of 13.5 percent return on original investment. This does not take into consideration that the total $20,000 is not outstanding for the entire period. A portion would be returned each year through earnings. Many investors using the return-on-investment concept calculate the return on average investment. This means that the relationship or ratio is between one half of the original investment, or $10,000, and earnings of $2,700, indicating a return on average investment of 27 percent.

A third method of calculating returns, the "discount flow" method, does take into account the time value of money. This concept allows an adequate measurement of economic value for an investment by equalizing the present value of the money invested with its value if the investment is delayed for a given number of years. If earnings vary from year to year, they must be computed for the discount flow method. This procedure considers the variable income of one or both investments over time, and gives a true rate of return on invested capital.

Adequate cost data are a must if management is to make appropriate decisions on capital investment. For accurate analysis, such cost information is needed as current repair costs of existing equipment, labor expended for handling the particular operation, time lost from breakdowns of existing equipment, and how long it will take for capital investment to pay for itself and return a profit. Management must have these data in making decisions so they will know whether a production cost saving can be effected in terms of labor or other operating expense.

INDUSTRY-MODEL COMPARISON

Survey plants regardless of size had certain basic similarities. These similarities were more pronounced between plants in the same region of the country or with similar production schedules.

Models in this report are assumed to be packaging 80 percent of the total feed output of the mills. Survey plants of a size comparable to the smaller model packed from none to 90 percent, and those comparable to the larger model packed from none to 98 percent. Bulk feed sales have influenced the manufacturing operations for many feed plants.

Most feed plants of comparable volume in the survey had more scales than are used in the models. About 60 percent of the plants producing 80 tons a day had more than one scale; about one-third had between 3 and 5 scales. The majority of the plants had scales that were of low capacity or that were only used a small portion of the work time. In the group of plants similar to the larger model, about 50 percent had 2 or more scales in use; one-half of these had 3 or more scales.

In the smaller mills there was a definite relationship between the number of scales in the packing center and the output for each scale. These mills tended to keep the low-capacity scales in operation longer than the larger plants, a greater percentage of which had replaced inefficient scales with more automatic types. It would be possible for some of the smaller mills to replace from three to five of their smaller scales with one or two newer models of greater capacity.

Many plant managers are faced with the problem of locating a new scale in a central position convenient to all the storage bins. This is a particularly serious problem with the older mills. Location of bins may be such that a gravity flow from all bins into one scale is impossible. Some mills use belt feeders to convey the material from the bottom of the bin hopper over to the scale. This is expensive and creates other problems. Sometimes it is difficult to handle molasses or bulky feed with this arrangement and, more important, feeds may become contaminated.

The plants surveyed showed a definite tendency to use more labor with the greater number of scales or packing lines. Some of the more efficiently operated plants shifted packing crews from one scale to the other. About 40 percent of the mills surveyed had, on the average, one man packing for each scale while 10 percent of the plants averaged less than one packing operator per scale. The remaining 50 percent of the plants had two or more assigned men for each packing scale in use. In some of the small to medium-size plants, survey data indicated that the packing operation was less specialized and that production workers in other parts of the plant were doing some of the packing of finished feeds. In some instances, this may have been the most efficient job assignment with a particular arrangement of plant facilities.

Mills in the survey similar to the smaller model required on the average 0.34 man-hour of production labor per ton compared to the standard in the model of 0.14 man-hour. Man-hours required for individual plants varied from a low of 0.16 to a high of 0.83 man-hour per ton. Survey mills comparable to the larger model used an average of 0.26 man-hour for every ton of feed packed. The model used 0.10 man-hour per ton. The range in the survey plants was from 0.10 to 0.56 man-hour per ton of feed packed.

These data indicate the need for increased efficiency by many plants but, more importantly, they show that some plants in the industry have reached the levels achieved by the models. In general, the degree of efficiency attained in the packing center was reflected in the operation of the various other cost centers in the plant.